ABSTRACT OF THE DISCLOSURE

A chain rule-based evaluation technique is presented for analytically evaluating partial derivatives of nonlinear functions or differential equations defined by a high-level language. A coordinate embedding strategy is introduced that replaces all scalar variables with higher-dimensional objects. The higher dimensional objects are defined by a concatenation of the original scalar and its Jacobian and Hessian partials. The artificial problem dimensions permit exact sensitivity models to be recovered for arbitrarily complex matrix-vector models. An object-oriented operator-overloading technique is used to provide a familiar conceptual framework for generating the model sensitivity data. First- and second-order partial derivative models are automatically evaluated by defining generalized operators for multiplication, division, and composite function calculations. The new algorithm replaces a normally complex, error-prone, time-consuming, and labor-intensive process for producing the partials with an automatic procedure, where the user is completely hidden from the details. The algorithm supports both numerical and symbolic model generation. Module functions are used to encapsulate new data types, and extended math and library functions for handling vector, tensor, and embedded variables. Current capabilities support math models for scalar, vector, linear matrix equations, and matrix inversion. The algorithm has broad potential for impacting the design and use of mathematical programming tools for applications in science and engineering. Several applications for presented demonstrating the effectiveness of the methods.